NEW PUSHBUTTON INTERCOMMUNICATION TELEPHONES

BY strict definition all telephone systems provide intercommunication by virtue of the connexions that can be established between all instruments. The term intercommunication telephone, however, has come to be applied as the generic title of those telephones which are so designed that several may be linked by wires directly to each other, without the need for an exchange. With such telephones, the user establishes the connexion he desires with any other party on the system, simply by pressing the appropriate button on his telephone. Convenience in use is thus particularly marked because the pressure of a single button, which is generally designated with a name—not a number, replaces the dialling of digits or the verbal request that are necessary with exchange systems.

An upper limit is imposed on the practicable size of these intercommunication systems by two principal factors. The first of these is that as the number of stations on a system increases so also must the number of wires in the cable linking all telephones. The second is that for each station on the system a pushbutton must be included in the assembly of each other telephone, and from this multiplicity of pushbuttons the user must make his choice to originate a call. The number of stations included in a system must therefore be limited to prevent these factors from becoming disadvantages.

A convenient size of desk or wall-type telephone and a practicable and economical size of cable, permit 21 stations to be a reasonable maximum. This means that each telephone has lines to 20 others and is therefore called a 20-line instrument. The fact that a 20-line instrument operates in a system that could have up to 21 stations should be noted.

A system that could incorporate 21 stations could be equipped for any number up to this total. The telephones would be complete with the full complement of pushbuttons and the cable complete with the full quota of wires. Only the required number of telephones would be connected initially, the balance being installed later if extensions were required. The practice is economically sound provided that more than ten or eleven stations are needed initially For systems which are not expected ultimately to exceed eleven stations, a telephone fitted with ten buttons instead of twenty, and a cable with a reduced number of wires, offer economy in cost. For the smallest installations, economy is served by telephones designed for a maximum of five lines, that is, six stations.

New Instruments

The new G.E.C. intercommunication telephones of the familiar pushbutton type are therefore of two capacities—20 lines and 10 lines, and have as a companion design for the smallest installations a completely new telephone of five lines capacity. The present intention is to describe the 20-line and 10-line instruments, deferring the 5-line telephone for the description that begins on page 41.

Fig. 1.—10-line telephone.

Fig. 2.—20-line telephone, for desk use.

The shapes and sizes of the 10-line and 20-line instruments are the same but one has a row of ten buttons and the other two rows each of ten (Figs. 1 and 2). The plastic cases have pleasing lines and are free of such dust traps as slots, grooves and screw heads. The labels to the buttons appear under transparent covers, which keep the designations permanently clean and legible.

The design is specially arranged so that the instrument may lie on a desk or be fitted to a wall (Fig. 3). The switch-hook arms hold the handset securely, and, whether the base be horizontal or vertical, no modification is needed except that the multi-core cord and terminal strip for the looping-in of the line cable, are not needed for the wall instrument.

Use

For a call to another station, the handset is lifted and the appropriate button depressed. Pressure beyond the locking position closes contacts to operate a buzzer at the wanted station. When pressure is released the buzzer stops and the button remains in the locked position to prepare a speech circuit. The called party simply lifts his handset and the speech circuit is complete.

At the end of conversation, the restoration of the handset at the calling station mechanically unlocks the pushbutton, which returns to its normal position.

Batteries

Since the appropriate circuit conditions are established by the mechanical action of pushbuttons, there is no automatic apparatus to require battery supplies. Two batteries, one of two dry cells and one of three, suffice to supply current for speech and buzzers and their capacity is immaterial within

Fig. 3.—20-line telephone for wall mounting.

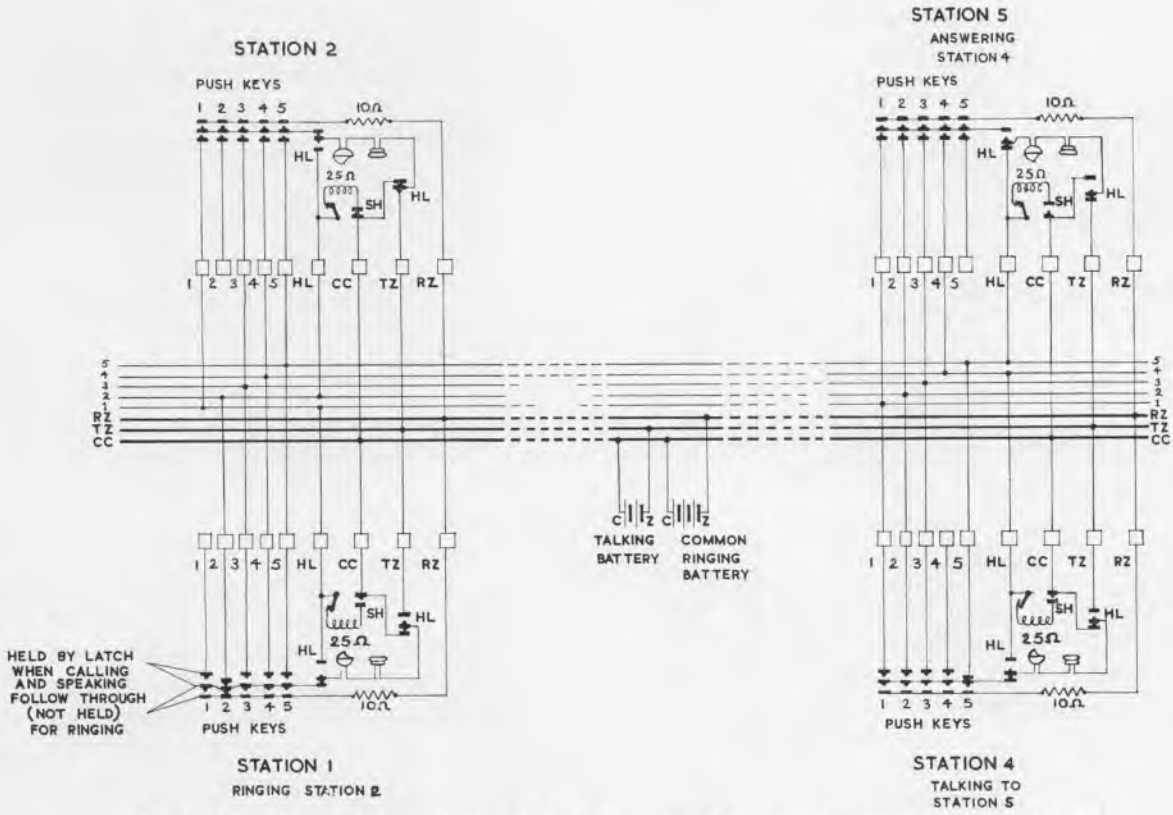

Fig. 4.—Circuit conditions, station 1 ringing station 2, and station 4 talking to station 5.

reason except, of course, that the larger the capacity the longer the period between replacements. To give freedom from the need for battery replacement a small mains unit has been designed.

Circuit

The diagram given in Fig. 4 shows the circuit conditions for one station ringing another and one station talking to another.

Taking the ringing circuit first, there is a connexion from the negative terminal of the ringing battery, to the RZ terminal of station 1, via the depressed key to terminal 2, thence to line-wire 2 and terminal HL of station 2, buzzer winding and switch-hook contacts SH to terminal CC, and thence over a battery wire to the positive terminal of the ringing battery. Thus, until the handset is lifted in reply, the buzzer in station 2 continues to operate as long as the button is fully depressed in station 1.

For the talking circuit shown between stations 4 and 5, there is a connexion from the negative side of the talking battery to the TZ terminal of station 5, through HL contacts, to receiver and transmitter, HL contacts to terminal HL, thence to line-wire 5, terminal 5 on station 4, via HL contacts, transmitter and receiver to terminal CC, and thence by battery wire to the positive terminal of the talking battery.

The HL contacts operate when a handset is lifted and restore when a pushbutton is depressed or the handset replaced, with resulting circuit conditions as shown in Fig. 4.

From the diagram can be seen that the line wire for station 1 is looped in to terminal 1 at all instruments except its own, where it goes to terminal HL (home line). This leaves terminal 1 and the associated key at station 1 available for another line and gives 21 stations on a 20-line system.

A New Loudspeaking System

The ultimate in speed and convenience is obtained when the telephone allows conversation to be carried on as if the parties to it were in the same room, with freedom of movement to arrange papers or consult files whilst continuing the conversation. To free the user from the restrictions imposed when one hand is required to hold the handset, loudspeaking telephones have been designed, to reproduce incoming speech so that it shall be heard in any part

Fig. 5.—10-line Loudspeaking Master Station.

of a room of reasonable dimensions and to transmit speech from any point in the room. When conversational facilities of this kind are allied with the ease of calling of the pushbutton system, then the telephone reaches its maximum level of convenience.

Instruments

The loudspeaking system incorporates the loudspeaking telephones shown in Figs. 5 and 6. Each consists of a polished walnut cabinet, with a grille behind which are located a loudspeaker and a microphone. Ten keys in the 10-line model, and twenty in the 20-line model, are designated with the names of the other parties on the system, any of which is called by depression of the corresponding key.

One, two or three of these telephones (called master stations) may be allotted to busy executives on the system, the remaining parties using substation sets of the type illustrated in Fig. 7 There is a marked similarity in appearance between these substation sets and those already described. They have the same shape, their cases are in black plastic, there is a freedom from dust traps and they can be mounted on table or wall without modification. The outward differences lie in three panels, which are illuminated from inside on calls from master stations, and three coloured pushbuttons which the user depresses for calls to or from master stations.

Master station calls a substation

The depression of a key at a master station to call a substation results, should the substation be disengaged, in a continuous buzz at the called telephone. At the same time one of the three lamp panels glows to indicate the identity of the caller. The call is answered by the lifting of the handset and the depression of the button associated with the calling master station.

Should the substation be already engaged, then the audible signal to attract attention to the telephone is not necessary and is therefore not given, but the lamp panel glows to indicate that a call from a master station is waiting. The substation user then interrupts his conversation and depresses his coloured button for the particular master station.

Circuit conditions then permit conversation, the loudspeaker and microphone being used at the master station. At any time, the handset may be taken into use at the master station to prevent the entire conversation being heard by others in the room. Lifting the handset automatically disconnects the loudspeaker and microphone.

Fig. 6.—20-line Loudspeaking Master Station.

Fig. 7.—20-line substation telephone, for use with Loudspeaking Master Station.

Master station calls a master station

A factor to be taken into account in the design of any loudspeaking telephone system is the possibility of acoustic feedback. If some part of the energy of incoming speech, as reproduced at high level in a loudspeaker, were to be picked up by the microphone in the same instrument and thereby reproduced at the distant end, being there in turn picked up by the microphone, a constant circulation of energy would result, with consequent singing.

With a loudspeaker at one end and a handset at the other, as when a master station is connected to a substation, the level of reproduction and the low degree of acoustic coupling at the handset prevent feedback, but with two master stations connected together, the high level of reproduction at both ends and the sensitivity of the microphones produce sufficient feedback to make singing probable.

The trouble could be avoided by including manual switching facilities or voice-operated devices. The first are extremely inconvenient and the second are complicated and costly. Much the simplest, cheapest and most convenient practice is to omit all complications and for a call from one master station to another to be made on the handset at the calling station.

Calls to a master station

Incoming calls to a master station are signalled by the glowing of the designation panel bearing the name of the caller At the same time, should the master station be disengaged, a buzzer sounds to attract attention to the telephone. With a conversation already in progress, the panel glows but the buzzer does not operate. The only action required to answer the call is depression of the key associated with the glowing panel. The lamp is thereby extinguished and the buzzer circuit broken.

A small switch is provided to change the audible calling from a buzz to a click should a quieter signal be sufficiently effective.

Calls between substations

One substation calls another by depression of the appropriate button, applying sufficient pressure to take the button past the locking position in order to close a circuit for the distant buzzer On the release of manual pressure, the button locks in the speech position. The reply is by the lifting of the handsets. At the end of conversation, with the replacement of the calling handset, the button automatically returns to normal.

Secrecy and Priority

Once a master station is in conversation, no other station may establish connexion with either party to the conversation. Master station calls are therefore secret. The master station is never completely isolated, however, because, as already explained, an incoming call during an existing conversation is signalled for future attention by the glowing of the designation of the caller.

A master station is accorded priority when calling substations because the visual indication afforded by the glowing panel on a substation set will lead the user to interrupt his call to another substation in order to switch to the master station.

Performance

The required volume of reproduced speech is obtained without the use of an amplifier The sensitivity of the microphone, which is of the carbon granule type for high-level output, and the effectiveness of the loudspeaker, combine to give the results

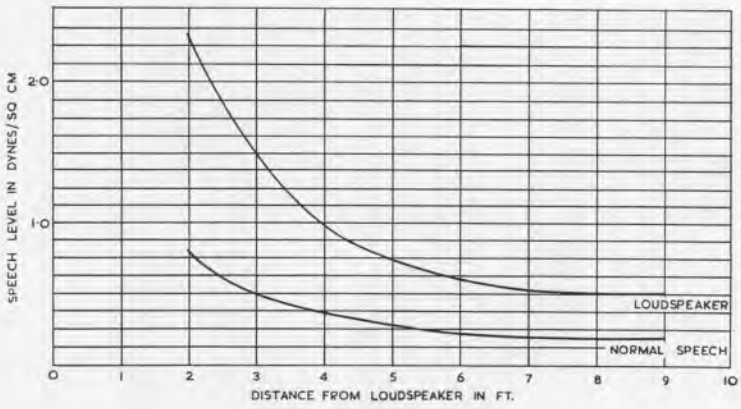

Fig. 8.—Speech-level/distance curves for loudspeaking telephone compared with normal speech.

shown in Fig. 8, where the level of reproduced speech at a distance of three feet from the loudspeaker in an undamped room is seen to be three times the level of actual speech at the same distance from the speaker. At greater distances the level is still substantially higher than with normal speech. The level of reproduced speech is, of course, a function of the level of speech at the distant end and the curves are derived from a series of observations upon normal users of the telephone and normal conversationalists.

Further tests were made to plot a polar diagram to show the relative speech levels for various angular positions at a fixed distance from the loudspeaker. The result is shown in Fig. 9. The polar diagram is a rather-surprisingly close approximation to a circle, the level immediately behind the loudspeaker being only 2.25db down with respect to the level immediately in front.

A similar diagram is obtained (Fig. 10) for the relative output from the microphone for a uniform speech level at a constant distance of eight feet along various radii.

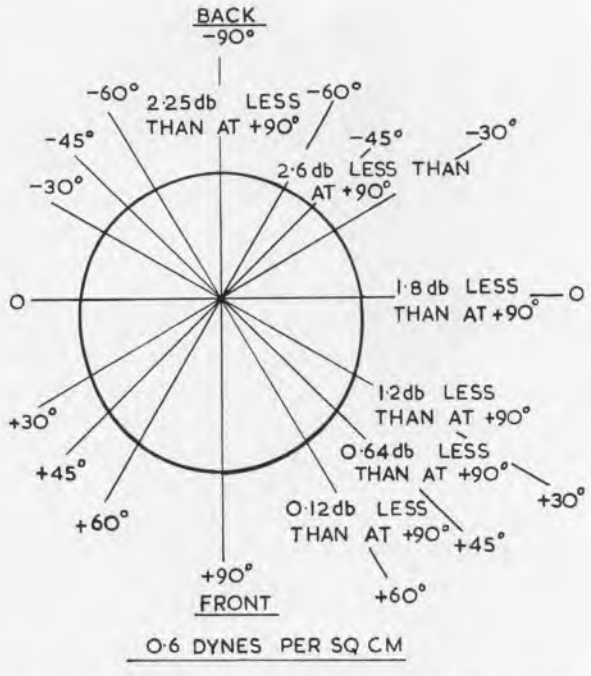

Fig. 9.—Polar diagram, speech level at constant distance from loudspeaker of 8 ft.

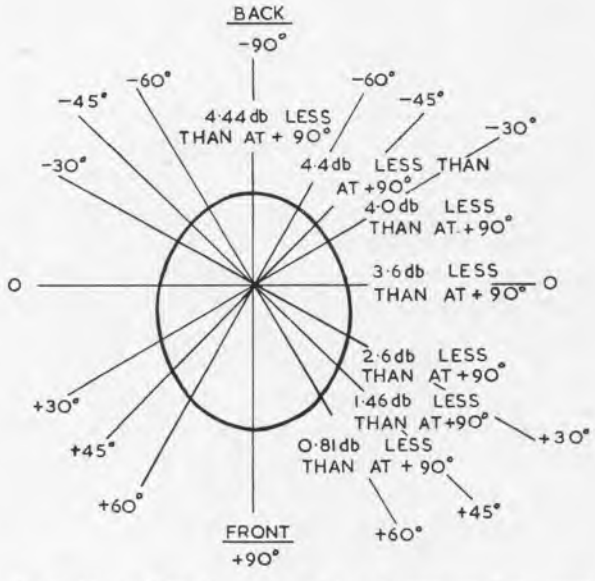

Fig. 10.—Polar diagram, microphone output, user speaking from constant distance of 8 ft.

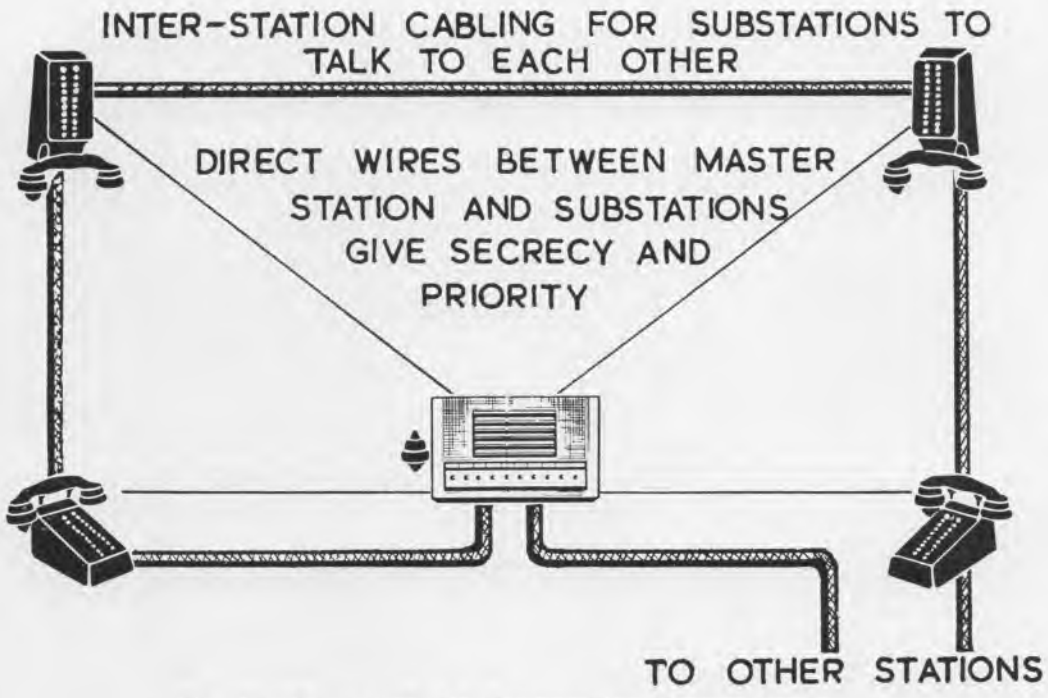

Fig. 11.—Connexions for Loudspeaking Master System.

Circuit

The circuit incorporates several special features. One of these is necessitated by the fact that with two master stations connected to each other, the handset being used at one and the loudspeaker and microphone at the other, a high-level output is required from the handset to provide sufficient input to the distant loudspeaker, but if the second handset should be taken into use then the output must be at once reduced to avoid excessive volume. This is achieved by relay switching, which is, of course, effective also in the opposite respect should the change be from handset to loudspeaker In consequence, whether the handset or microphone be used, the level of speech required from the user remains unchanged. The circuit arrangement is the subject of British patent No. 512354.

At the substations, relays are incorporated very compactly in the terminal strips to give the appropriate circuit conditions for master-station calls. One relay is fitted to each terminal strip for each master station included in the system.

Batteries

The achievement of the necessary levels without the use of amplifiers means that power supplies for the system are small and can be drawn from two dry batteries, each of 6 to 7½ volts, in addition to the talking and ringing batteries shown in Fig. 4.

Cable

The cable arrangements (Fig. 11) can be regarded as two separate systems. In one, a multi-core cable runs between all substations and the loudspeaking master stations, providing signalling and talking circuits for calls between substations and affording signalling circuits for calls to and from master stations. In the other, three-core screened cables run from each master station to each substation.

The voltages employed and the permissible level of crosstalk between wires in the multi-core cable allow the total length of cable, involving all looping-in, to be approximately a quarter of a mile for satisfactory speech between all parties.

Catalogue Leaflets ITL1 and ITL2 give full ordering information and will be forwarded on request.